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論文題目	Interpreting Radioactive Cesium Migration in Forest Soil after Fukushima Nuclear Accident: Monitoring and Modeling Approach (福島原発事故後の森林土壌中放射性セシウムの挙動解明：モニタリングとモデリングによるアプローチ)		

（論文内容の要旨）

This thesis presents a study on the mechanism in forest soils of radioactive Cs released from the Fukushima Daiichi Nuclear Power Plant accident by measurements in the field, experiments using columns and numerical modeling and is composed of six chapters.

Chapter 1 describes the background and the objective of the research and the outline of this thesis.

Chapter 2 describes the results of the analysis of the vertical migration of radioactive Cs in forest soils of the Takizawa research forest in Iwate prefecture. The reason for sampling the forest soils in Iwate prefecture is that it is difficult to enter the forest areas in Fukushima prefecture because of their high-level radioactivity and the characteristics of the forest soils in Iwate are similar with those in Fukushima. In this analysis, ^{137}Cs fallout caused by Fukushima accident was discriminated from that caused by atmospheric nuclear detonation tests. It was found that about 80% of ^{137}Cs in forest soils is present in the organic layer and the surface soil layer (2 cm in thickness) and ^{137}Cs was never detected in the deep soil layer (more than 20 cm in depth). It was also found that ^{137}Cs concentration in the deciduous forest soils was higher than that in the coniferous forest soils and ^{137}Cs concentration in forest soils varied widely according to locations, landforms and species of trees. ^{137}Cs in forest soils originated from atmospheric nuclear detonation tests which had been mainly practiced about 50 years ago is present in the soil layer at depths of 3.9 - 7.9 cm and ^{137}Cs in forest soils originated from Fukushima accident is present in the soil layer at depth of 1.5 - 3.9 cm. This shows that vertical infiltration of ^{137}Cs is relatively slow and variably changed with time. It was confirmed that vertical infiltration of ^{137}Cs showed a tendency to be faster in the soils with high organic contents and low bulk density.

Chapter 3 describes the development of a numerical model for the analysis of ^{137}Cs movement in forest soils. FORESTPATH model, one of the existing models for evaluating radionuclide distribution in forests from the Chernobyl Nuclear Power Plant accident, was modified to estimate the ^{137}Cs distribution in forest soils with revised parameter values. The modified FORESTPATH model is composed of twenty compartments and promising for estimating ^{137}Cs distribution in forest soils after Fukushima accident. The calculated values of ^{137}Cs distribution in forest soils were compared with the measured data shown in Chapter 2 and it was found that the calculated values agreed in general with the measured data. Therefore, it is confirmed that ^{137}Cs distribution in forest soils in 50 years ahead can be estimated using this model.

Chapter 4 describes the results of the analysis of the elution from soil surface and vertical infiltration in soil of Cs and Sr just after Fukushima accident by measurement in the field using stable Cs and Sr and experiments using columns for low level ^{134}Cs and ^{85}Sr. It was found that both Cs and Sr much eluted soon after rain. This means that the initial elution of Cs and Sr from surface soils depends on the movement of rapid flow element of soil pore water. It was also found that the percentage of Sr elution from soil surface is larger than that of Cs. This means that Cs more strongly adsorbs to soil surface than Sr. On the other hand, vertical distributions of Cs and Sr in forest soils showed a similar tendency. This means that vertical transfer of Cs and Sr in forest soils depends on the movement of slow flow element of soil pore water. These results show that movements of Cs and Sr in soils soon after Fukushima accident dominate their future distribution in soils.

Chapter 5 describes the modelling the migration and distribution of Cs and Sr in forest soils to simulate the results from the field and column experiments shown in Chapter 4. The proposed model was developed by using the existing three-component models for evaluating movements of soil pore water. This model is composed of thirty seven compartments. In this model, soil is divided into rapid flow element of soil pore water, rapid flow element of soil pore water and solid phase. The calculated values were compared with the measured data shown in Chapter 4 and it was found that the calculated values agreed in general with the measured data. Therefore, it is confirmed that this model can estimate the movement of Cs and Sr in forest soils soon after the accident. Moreover, this model was modified in order to estimate the movement of Cs and Sr in forest soils in several months ahead and several years ahead and it was confirmed that this model could simulate the long-term migration and accumulation of Cs and Sr in forest soils. In addition, this model was compared the modified FORESTPATH model shown in Chapter 3.

Chapter 6 describes the conclusions of this thesis and the future research subjects. In the future, the proposed models in this thesis should be modified for more realistic estimation by more measurements and considering the uncertainties of the model, taking the biological mechanism of tree into consideration.

The above results suggest a method for estimating the future migration and accumulation of radioactive Cs in the contaminated forest soils caused by Fukushima accident.